

LASE Measurements of Water Vapor and Relative Humidity During SOLVE

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The Lidar Atmospheric Sensing Experiment (LASE) Differential Absorption Lidar (DIAL) system was operated from the NASA DC-8 aircraft during the SAGE-III Ozone Loss and Validation Experiment (SOLVE) that was conducted over the Arctic region during November 1999-March 2000. LASE simultaneously measured water vapor, aerosol, and cloud profiles in both the nadir and zenith modes during 22 flights over the northern high latitudes. This paper presents examples of SOLVE LASE water vapor and relative humidity profiles, shows comparisons with in situ and remotely sensed profiles, and discusses the ice supersaturation conditions derived from the LASE and Microwave Temperature Profiler (MTP) profiles.

Comparisons of LASE tropospheric water vapor profiles with water vapor measurements acquired by cryogenic and laser diode hygrometers on board the DC-8 generally show good agreement for water vapor mixing ratios above 15 ppmv. LASE water vapor profiles were also compared with the tropospheric water vapor profiles measured by the Polar Ozone and Aerosol Measurement III (POAM III) spaceborne photometer. The LASE and POAM III water vapor profiles were found to agree within their respective uncertainties for regions above the POAM III lower altitude limit of about 8 km. Although LASE was designed to measure water vapor in the troposphere, preliminary processing indicates that with sufficiently long temporal (> 30 min) and vertical (> 2 km) averaging, stratospheric water vapor profiles may be derived using the LASE zenith measurements. Initial comparisons of these LASE zenith stratospheric water vapor profiles with POAM III water vapor profiles show good agreement.

Upper tropospheric relative humidity profiles were computed using the LASE nadir water vapor profiles and MTP temperature profiles. Relative humidity frequency distributions computed using these profiles acquired during December 1999 indicate that ice supersaturation occurred about 10-12% of the time for altitudes below 10 km and temperatures below -35 C. This frequency decreased to about 8% for cloud-free conditions. Ice supersaturation distributions computed using in situ water vapor and temperature measurements acquired on the DC-8 produced similar values indicating that in situ measurements did not significantly underestimate the fraction of atmosphere where ice supersaturation existed.